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IV. *A Letter from Arthur Dobbs Esq; to Charles Stanhope Esq; F. R. S. concerning Bees, and their Method of gathering Wax and Honey.*

S I R,

Castle-Dobbs, Oct. 22, 1750.

Read Nov. 8.
1750.

SINCE my View of doing Good, by making Discoveries of the Great World has been disappointed, upon my Retirement into this little Corner of it, [*Ireland*] amongst other rural Amusements I have been contemplating the Inhabitants of the Little World; particularly that most useful and industrious Society of Bees; and have had Time to revise the curious, ingenious, and entertaining Account given by M. *Reaumur*, of that inimitable Insect, with his curious Remarks and Reasoning about them; since he has been indefatigable in his Experiments and Observations about them, as well as of most other Insects, I think it the Duty of every Person, who has had Time to make any Observations, which may contribute to come at the Truth, and complete his Natural History of Insects, to throw in his Mite towards it.

I had Leisure and Opportunities many Years ago, to make some Observations about Bees; and all that I made confirm his general Theory, as well from his microscopical Observations, as those made by means of glass Hives; in which he had much greater and better Opportunities to make Observations than I have had: However, as there are two Things, in which my Observations are different from his, I think

think it but Justice to the curious and learned World to mention them; that M. *Reaumur*, in case he be alive, and still able to follow his Observations, or, if he is not, that some other curious Person may make future Remarks, to know whether those I have made are true: As I must own myself diffident of my own Observations, when they differ from so accurate, minute, and careful an Observer, as he has shewn himself to be throughout his whole Theory of Insects in general, and more particularly of the Society of our Garden-Bee.

I therefore beg Leave to lay the few Remarks I have made before you, Sir; that if you think there is any thing in them worth communicating, you may lay them before the *Royal Society*, of which you are a worthy Member; or communicate them to M. *Reaumur*, if he be still alive, and follows his Observations; that, in case my Observations are found true, he may so far alter his Remarks; and if they are not confirm'd, I shall willingly submit to his future Observations.

The only two things in which I differ from M. *Reaumur*, are, that I apprehend he says, the Bees range from Flowers of one Species to those of another Species, whilst they are gathering one Load; so that the *Farina*, or crude Wax, loaded upon their Legs, is from different Species of Flowers; which is contrary to what I have observed. The other thing that I differ with him in is, that he says the Wax is formed in the Bee, from the crude Wax, or *Farina* (so far I agree with him): But by his Observations, he says, after Digestion it is discharged upwards by the Mouth; whereas, by my Observations,

is

it is the *Fæces*, Husks, or Shells of the *Farina* or crude Wax, after Digestion, discharg'd by the *Anus*.

As to the first, I have frequently follow'd a Bee loading the *Farina*, Bee-Bread, or crude Wax, upon its Legs, through a Part of a great Field in Flower; and upon whatsoever Flower I saw it first alight and gather the *Farina*, it continued gathering from that kind of Flower; and has pass'd over many other Species of Flowers, tho' very numerous in the Field, without alighting upon or loading from them; tho' the Flower it chose was much scarcer in the Field than the others: So that if it began to load from a Daisy, it continued loading from them, neglecting Clover, Honeyuckles, Violets, &c.; and if it began with any of the others, it continued loading from the same Kind, passing over the Daisy. So in a Garden upon my Wall-Trees, I have seen it load from a Peach, and pass over Apricots, Plums, Cherries, &c. yet made no Distinction betwixt a Peach and an Almond

Now M. *Reaumur*, in his Memoir upon the Bee's making Honey, mentions *Aristotle's* Observation of the Bee's loading or gathering from one Species of Flower without changing; not quitting a Violet to gather from a Cowslip; which he says is not justly founded; for he has observed frequently a Bee on a large Border gathering from Flowers of different Species. If M. *Reaumur* only means, that, when the Bee gathers Honey, it takes it indifferently from any Flower, I can say nothing against it; but, if he intends it to mean the Bee's loading the *Farina* upon its Legs, then my Observation directly contradicts it.

What

What further confirms my Observation is this, that each Load upon the Legs of a Bee is of one uniform Colour throughout, as a light Red, an Orange, a Yellow, a White, or a Green, and is not upon different Parts of the Load of a different Colour; so that as the *Farina* of each Species of Flowers, when collected together, is of one uniform Colour, the Presumption is, that it is gather'd from one Species. For, if from different Kinds, Part of the Load might be of one Colour, and Part of another.

Another Observation to confirm the same Fact is, that Bees, in the Height of the Season, return to their Hives with Loads of very different Magnitudes, some having Loads as great as small Shor, whilst others have very small Loads; it cannot be conceiv'd that this Difference is from the Inactivity or Sloth of the Bee in collecting its Load, but rather from the Scarcity of the Flowers, upon which it first began to load.

Now, if the Facts are so, and my Observations true, I think that Providence has appointed the Bee to be very instrumental in promoting the Increase of Vegetables; but otherwise, might be very detrimental to their Propagation; and at the same time they contribute to the Health and Life of their own Species.

From the late Improvement made by Glasses, and Experiments made, in observing the Works of Nature, it is almost demonstrable, that the *Farina* upon the *Apices* of Flowers is the Male Seed; which entering the *Pistillum* or *Matrix* in the Flower, impregnates the *Ovum*, and makes it prolific. It is often necessary to have Wind and dry Weather to

waft this *Farina* to the *Piftillum*, and from Flower to Flower, to make the Seed prolific: And we find in wet Seasons, that Grain, Nuts, and Fruit, are lefs prolific, by the *Farina*'s not being properly convey'd to the *Piftillum*; and alfo in very hot dry Weather, from clammy Honey-Dews, or, more properly sweet Exudations from the Plants themfelves, which clogs the *Farina*, and caufes Blasts and Mildews. Now, if the *Farina* of fpecifically different Flowers fhould take the Place of its own proper *Farina* in the *Piftillum*, like an unnatural Coition in the animal World, either no Generation would happen, or a monftrous one, or an Individual not capable of further Generation.

Now if the Bee is appointed by Providence to go only, at each Loading, to Flowers of the fame Species, as the abundant *Farina* often covers the whole Bee, as well as what it loads upon its Legs, it carries the *Farina* from Flower to Flower, and by its walking upon the *Piftillum* and Agitation of its Wings, it contributes greatly to the *Farina*'s entering into the *Piftillum*, and at the fame time prevents the heterogeneous Mixture of the *Farina* of different Flowers with it; which, if it stray'd from Flower to Flower at random, it would carry to Flowers of a different Species.

Befides thefe vifible Advantages, it may be of great Benefit to their own Species and Society; for, as this *Farina* is the natural and constant Food of the Bees, during one Half of the Year, and from this digefted, as it is accurately obferved by M. *Reaumur*, is the *Bouillée* and Jelly formed; which is lodg'd for the Food of the young Bees, until they become

Nymphæ:

Nymphæ: It is also necessary that Stores of it should be lodg'd in the Cells adjoining to the Honey for their Winter Provision; without which Mr. *Reaumur* observes they would be in Danger of dying of a Looseness, their most dangerous Malady.

It seems therefore highly reasonable to believe, that different Kinds of *Farina* may have different physical Qualities: So that, by making Collections of the same kind in each Cell, they may have proper Remedies for themselves against Ailments we have no Knowledge of, which otherwise they would not have, if they were filled at random from all Kinds of Flowers. These further Advantages, directed to them by Providence, seem to add Weight to my Observations, and are a presumptive Proof that they are true.

The only thing, besides the former, wherein my Observations differ from Mr. *Reaumur*, is in the Manner the Wax is made and emitted by the Bee. I absolutely concur with him, that the Wax is formed by Digestion in the Bodies of the Bees, and is emitted by them, and then becomes Wax; and that it is almost impracticable to form Wax any other Way, unless the Wax extracted from the Myrtle-berries in *America* by boiling be an Exception from it.

By M. *Reaumur*'s Observations, he forms his Opinion, that after the Bee has fed upon the *Farina*, or Bee-Bread, and it has pass'd through the first Stomach (which is the Reservoir where the Honey is lodg'd, from whence it is discharg'd upwards by its Mouth into the Cells) it is convey'd into the second Stomach; and yet, when there, great Part of it continues in its spherical or oval Form, still undigested,

as view'd by him with his Glasses; and consequently must be convey'd further, before it be thoroughly digested, and the Particles broke; yet this he supposes is reconvey'd upwards through both the Stomachs, and is emitted by its Mouth; and forms his Judgment from his Observation, that the Bee, when working, and finishing the Cells, nips with its Teeth the Wax, where it is too thick, or wrong laid; and has observed a Motion of its Tongue as it were smoothing or laying on more Materials, which he thinks must be then discharg'd from the Stomach by its Mouth.

What makes me disagree with him in his Opinion and Observations, is from the Remarks I have made, that the *Fæces* of the Bee discharg'd by the *Anus*, after the *Farina* is digested, is the true Wax. We may with Truth believe, that the *Farina*, which is the male Seed of all Vegetables, consists of a Spirit or moving Principle, floating in a sweet Oil, surrounded by an exterior Coat or Shell, in which is that *Monade* that impregnates the Grain or Fruit, and makes it prolific; that, upon Separation or Digestion, this Spirit and Sweet Oil becomes the Nourishment of the Bee; which Spirit is of the same Nature with the Animalcules in *semine masculino* of Animals, and becomes the animal Spirits in the Bee and other Animals; and perhaps the true Honey is the sweet Oil included in the *Farina*: And as all Vegetables abound with these vegetable vivifying Atoms, since, from many, every Bud is capable of increasing each Species, so the true Honey breaking through its Shell by great Heat, occasions those Honey-Dews observ'd in hot Weather upon the Leaves and
Flowers

Flowers of most Vegetables; which is no more than an Exsudation from the Leaves and Blossoms of these Vessels that break with the Heat; besides those that appear on the *Apices* of Flowers, which afterwards impregnates the Fruit.

Of this inward Substance of the *Farina*, diluted with Water, after Digestion, is formed the *Bouillée* and Jelly, which the Bees discharge upwards by the Mouth, into the Cells, to nourish the young Bees until they become *Nymphæ*; whilst the Husk or outer Coat is discharg'd by the *Anus*, and becomes the genuine Wax.

I have frequently, when Bees have been swarming, had them alight upon my Hands and Cloaths; and many, at different times, have discharged their *Fæces* thereupon: This I have taken off, and found it of the Consistence of warm Wax, with the same glutinous adhering Quality, not crumbling like the *Farina*. I have also distinguish'd it by the Smell to be Wax; but it had a heavier stronger Smell, as it was fresh and warm from the Bee.

What further confirmed me in this Fact, was from my Observation of the Bees when working up their Comb in a glass Hive; where I have constantly seen (and must believe it impossible not to be observed by so accurate an Observer as M. *Reaumur*) that several Bees, soon after one another, have by hasty Steps, walk'd along a Comb then forming, for the Length of two or three Cells, bending their Tails to the Comb, and striking it with a wriggling Motion from Side to Side, in a zigzag Way; which I was convinced was discharging their *Fæces*, or the Wax, against the Border of the Cells, as they

they ran along, and repeated it as long as they had any to discharge, and then quit it; which is the Reason why the outward Border of the Cells is so thick and strong: And immediately afterwards, other Bees came along the Cells, and with their fore Feet rais'd up the Borders like Paste, and thinning it, whilst other Bees were ripping off with their Teeth, and pruning away any irregular Excrefcences, so as to make the Divisions of the Cells vastly thinner than the Borders or Edges, which were always thick and strong, from the discharging the *Fæces* or Wax upon them.

M. *Reaumur* has very justly observed, that, besides the three transparent smooth Eyes, which the Bee has placed in a Triangle betwixt the *Antennæ* on the Top of its Head, the Bee has also on each Side of its Head an Eye, or rather a Multitude of Eyes, form'd by a Number of distinct *Lens's* surrounded each with short Hairs, which are confirm'd to be Eyes, both from *Swammerdam*, and his own Experiments to determine it; and that, notwithstanding these *Lens's* are lin'd with a dark opaque Substance, yet they assist so much their Vision, that, when darkened by Paint laid over them, the Bees could not find their Way to their Hive, tho' at a small Distance, but soar'd directly upwards; nor could they find their Way when the three smooth Eyes were darkened.

But there is one Observation, which I don't find he has made, which may have determined the Garden Bees to make almost all their Cells imperfect Hexagons. The Observation is this; that these opaque Eyes on each Side of the Head, consist of many *Lens's*, each of which is a perfect Hexagon; and the
whole

whole Eye, when view'd in a Microscope, appears exactly like a Honeycomb: Now, as the Eyes compos'd of these hexagonal *Lens's*, are in full View to the other Bees, does it not seem that Providence has directed them so as to be a Pattern set before them, for the Bees to follow in forming their Combs? Is it not also reasonable to believe, from the Disproportion of the Convexity betwixt the three smooth transparent Eyes, and the *Lens's* of the dark rough Eyes, that they are appointed for different Purposes? why may it not be thought that the *Lens's* are great Magnifiers, to view things nigh at hand, and by many Reflexions to convey Light into the dark Hives, where Light is still necessary; and that the three other Eyes are to observe Objects at a great Distance, so as to conduct them abroad to Fields at a Distance, and back again to their Hives?

I agree with M. *Reaumur* in the Form and Use of the Fang or Tromp of the working Bee, and of the Use of the Mouth within the Teeth of the Bee; so that it does not suck, but laps or licks with its rough Fang or Tromp, like a Dog. But I have never observed the Bee nipping or breaking open the *Apices* of Flowers, to let out the *Farina*, when it is not fully blown or open; but have often with Pleasure observed the Bee gathering the *Farina* upon its Fang, by licking it off the *Apices*, and laying it upon the first Pair of Legs, which convey it to the second Pair, and these lodge it upon the Pallet of the third Pair, with surprising Briskness; so that, by the time the second Pair has lodg'd it upon the third Pair, the Bee has gather'd more, and lodg'd it on the fore Legs; so that all are in constant Motion.

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From the curious Observations made by M. *Reaumur*, upon the Structure and Behaviour of the Queen or Mother-Bee, the Drone or Male Bee, and the working or Mule Bee, which is of neither Sex; from the Queen Bee's being so exceedingly prolific, as to lay from 30 to 40000 Eggs of working Bees in a Season; besides the Eggs of 800 Male Bees, and of eight or ten Queen or Mother Bees; and from the Coldness of the Male Bee, who so long resists the Caresses of the Queen or Female Bee; and also from the indefatigable Labour and Oeconomy of the working Bee, to nourish the young Bees, make up the Combs, and lay in Stores of *Farina* and Honey for Winter. I think very good Reasons may be given why the Queen should have a Seraglio of some Hundreds of Male Bees; and why the working Bee should destroy the Males, when no longer necessary to impregnate the Eggs of the Mother Bee.

It is evident, from the Oeconomy of the Garden Bee, that Providence has appointed that they should share their Store with Mankind, by making them so industrious in every Climate, as to provide, in tolerable Seasons, a Store of Honey and Wax, double of what is necessary for their Subsistence during the Winter, and of Combs for the Queen's laying her Eggs in Spring, before new Work can be made. From the vast Number of Eggs which the Queen lays in a Season, it is absolutely necessary that she should have a great Store of Male Sperm, to impregnate her Eggs; and as the Eggs are not sensibly large in her Body for 6 Months after her Coition with the Males, who die, or are killed, in *August*, and she does not begin to lay from that time till

February

February or *March*; it is therefore necessary that she should have a great Store of Male Sperm within her, to impregnate all the Eggs she lays from that time, until *June* or *July*, when young Drones or Males are hatch'd, who are not designed for her Use, but for the young Queens, who go off with the Swarms, or for the young Queen who succeeds the old one in the old Hive; since the Drones are great Feeders, and no Workers; and are of no Use, but to give a sufficient Store of Sperm to the Mother-Bee; as the working Bees have so many Enemies to deprive them of their Store, they can't be maintain'd during the Winter, even if their Life should last so long; and as it is probable each Male has but one Act of Coition with the Queen, as they are so cold, and take so much carelling before they act, and, by M. *Reaumur's* Observation, die soon after the Act is over, when, probably, their whole Store of Sperm is exhausted in that Act, as soon as the Queen has got as much Sperm lodg'd in the proper Reservoir, as is sufficient to impregnate all her future Eggs, the Males are no longer of Use; and if those who have acted, die, those who have not, being of no further Use, are killed by the working Bee, out of Oeconomy to save their Winter Store, when, probably, by Nature they could live but few Days more; as we find the Silk-worm Moth dies soon after the Eggs are laid, as well Males as Females. It seems therefore necessary that the Queen should breed so many Males, as, by one Act of Coition from each, may impregnate all her Eggs, and that the working Bee should dispatch them, as soon as that is over, and a Store is lodg'd.

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There are two Vessels describ'd by *Swammerdam* in the Mother-Bee, whose Plate M. *Reaumur* has given in his Memoirs; one of which is placed betwixt the two Lobes of the *Ovarium*, which he supposes to be a Bladder to contain Air; the other is a spherical Vessel, seated close by the common Duct, in which the Eggs fall from the Lobes of the *Ovarium*, which he supposes is to ooze out a Juice to moisten the Eggs in their Passage. I take one of these, but most probably the last, to be the Reservoir and Repository of the Male Sperm, wherein it is lodg'd from the Act of Coition, until the Eggs are enlarg'd, and pass thro' the adjoining Duct from the two Lobes of the *Ovarium*.

Since the Preservation and Increase of Bees are evidently beneficial to the Public, I approve very much of M. *Reaumur's* Instructions in driving Bees from a full Hive into an empty one, in case it can be done time enough to have new Work, sufficient for the Queen to lay her Eggs in in Spring; since they can be fed at very little Expence, if Care be taken to keep them in a middle State of Stupescation, neither too hot nor cold, during the Winter: But I approve much more of his castrating or sharing the Combs with the Bees, by taking the Combs best stor'd with Honey, and leaving those wherein are the *Nymphæ* and Bee-bread; but think in taking the Combs a safer and easier Way may be taken, than he directs: His Method is to stupefy the Bees with Smoke, to oblige them to croud together in the Crown of the Hive, and then turning up the Hive, and cutting out the Combs fill'd with Honey. Now I think, that turning up the full Hive, and setting an empty Hive upon it,

it, and driving the Bees into it, is preferable to smoking: For then a very few Bees will remain in the full Hive; and those few may be stupefied, and the Bees in the empty Hive being put on a Table, the Combs may be taken out and selected at leisure, without Hazard; and afterwards the empty Hive may be turn'd up, and their old Hive set over them, so that they will go up without Scruple into their former Hive, and repair their Work, by making new Combs: And if the Queen had not quitted the old Hive, as is often the Case, then they would return to their Queen, and the Society would not be lost, as is sometimes the Case, in driving into an empty Hive.

These, Sir, are the few Remarks I have made on revising M. *Reaumur's* curious Observations on Bees, which I thought incumbent upon me to send you, to lay before your Learned *Society*, if it may contribute towards finishing the Natural History of Bees. I shall take up no more of your Time, than to assure you, that I am, with the greatest Regard,

S I R,

Your most obedient, and most humble Servant,

Arthur Dobbs.